

# The role of glacier retreat for Swiss hydropower production

Bettina Schaefli<sup>1,2</sup>, Pedro Manso<sup>2</sup>, Mauro Fischer<sup>3,4</sup>, Matthias Huss<sup>3,5</sup>, Daniel Farinotti<sup>5,6</sup>

1: Institute of Earth Surface Dynamics, Univ. Lausanne, 2: Lab. of Hydraulic Constructions, Ecole Polytechnique Fédérale Lausanne, 3: Department of Geosciences, Univ. Fribourg, 4: Department of Geography, Univ. Zürich, 5: Lab. of Hydraulics, Hydrology & Glaciology, ETH Zurich, 6: WSL (all Switzerland)



## Introduction

Wide-spread **glacier retreat** since the development of hydropower production (HP) infrastructure = **depletion of long-term water storage** that cannot be replenished by precipitation in the coming decades.

- ➔ Role of glacier mass loss for high elevation / high latitude HP ?
- ➔ Past & future share of Swiss HP from glacier mass loss

Reference: Schaefli et al., The role of glacier retreat for Swiss hydropower production, submitted to Renewable Energy

## Case study

Switzerland produces over 50% of its electricity from hydropower (Fig. 1). Available water resources from precipitation are around 1300 mm yr<sup>-1</sup>.

- ➔ Glacier mass change for all Swiss glaciers from 1980 to 2010 = - 620 mm yr<sup>-1</sup> (relative to the glacier area in 2010, i.e. 944 km<sup>2</sup>)

Source: Fischer et al., 2015

- ➔ Relative to Swiss area (41'285 km<sup>2</sup>): -14 mm yr<sup>-1</sup>.

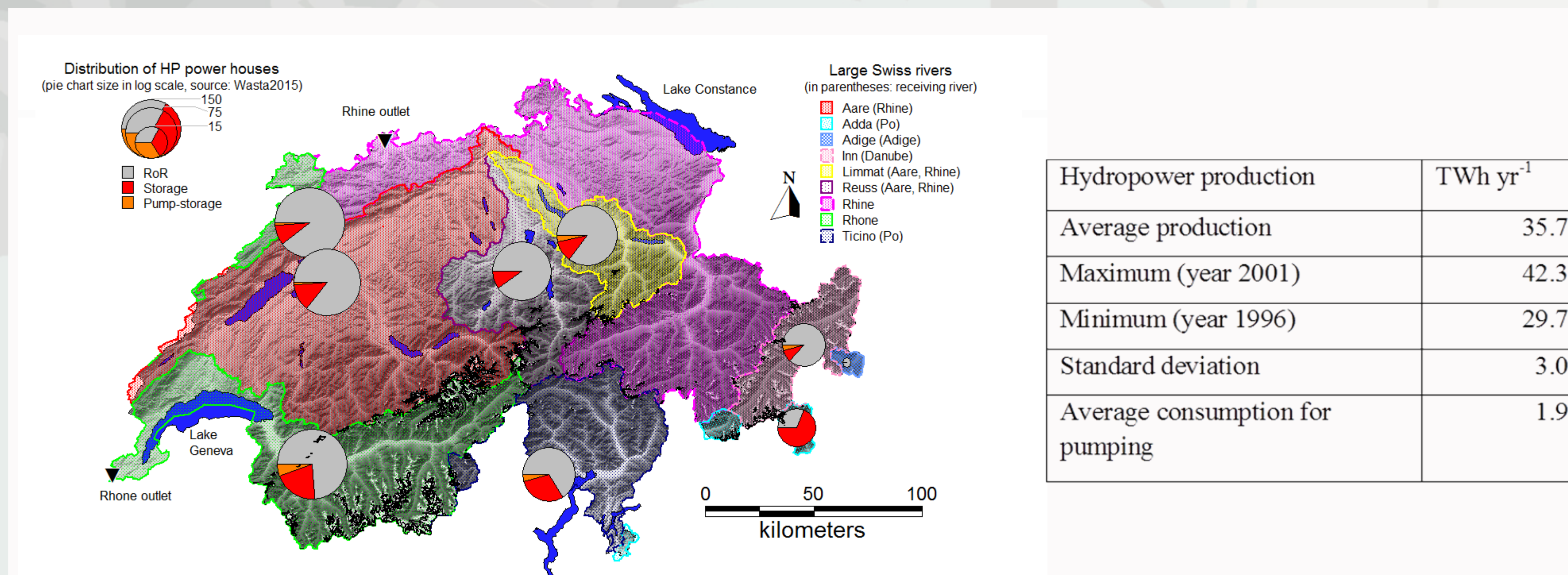


Figure 2: Left: Distribution of main types of HP powerhouses in the nine main Swiss river catchments; right: average HP (1980 – 2016); data source: Swiss Federal Office for Energy, 2015, 2016

## Assessment framework

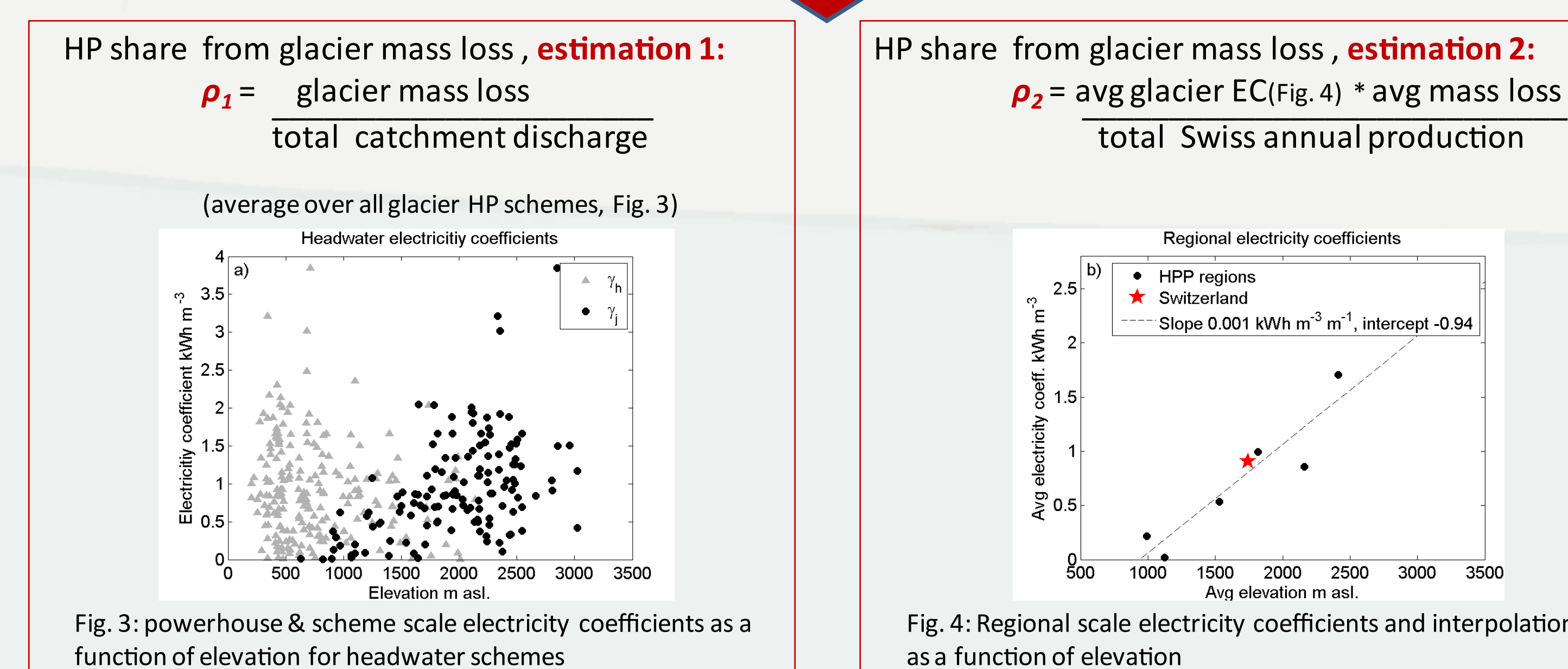
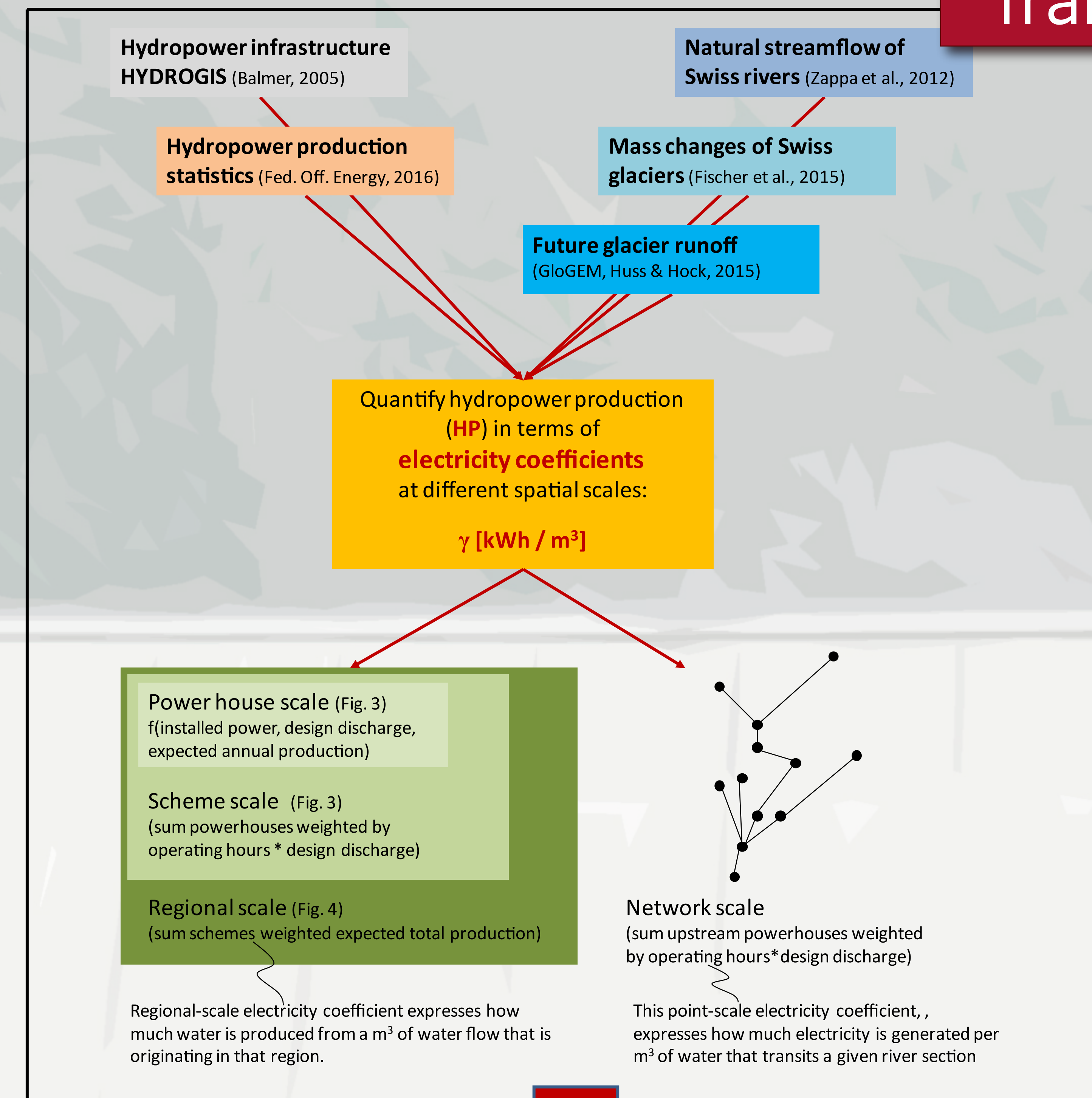


Fig. 2: Assessment framework developed for the analysis of HP from glacier mass loss at different spatial scales, for the past (1980 – 2010) and for two future periods (2040-2060 and 2070 – 2090).

## Results

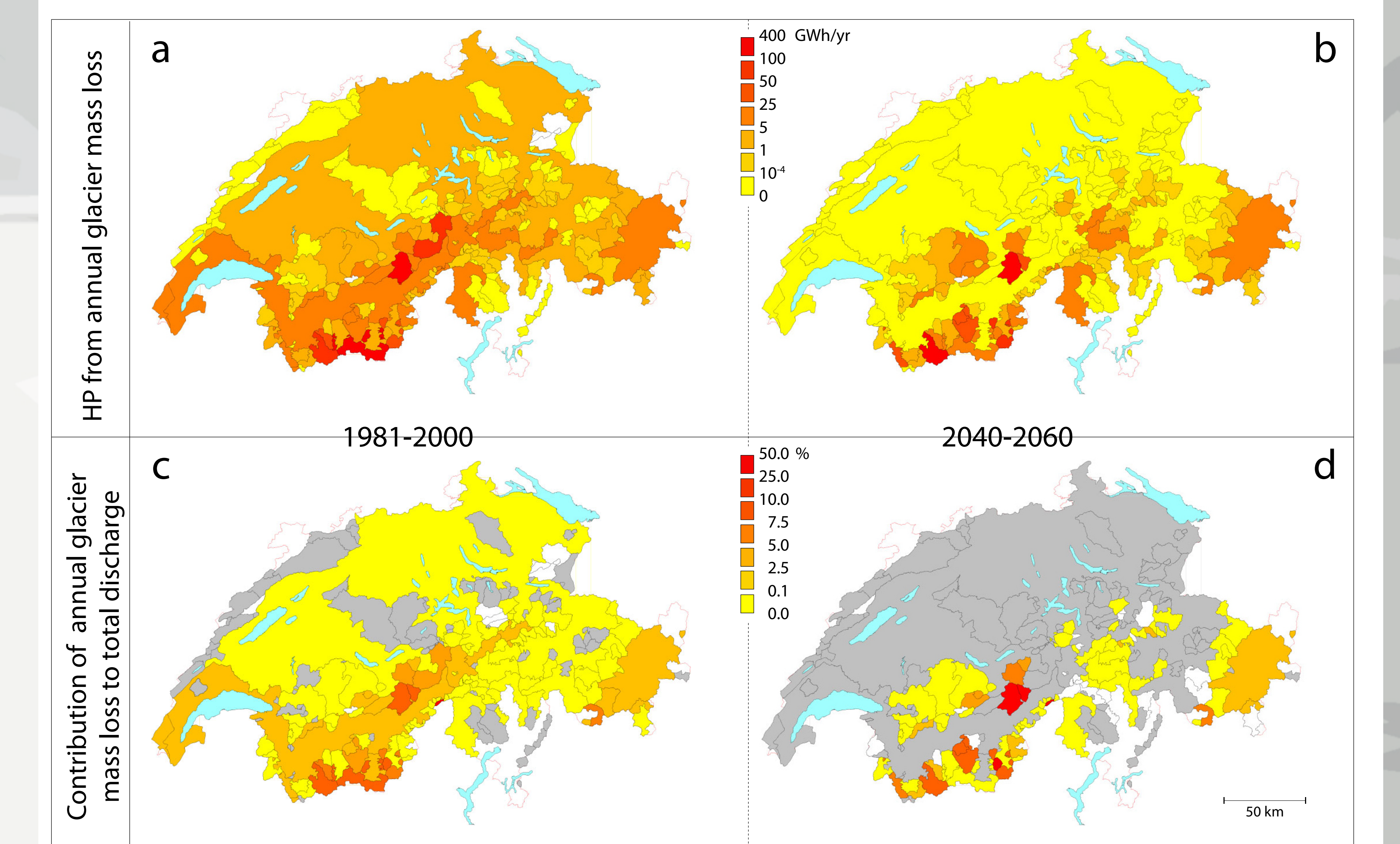
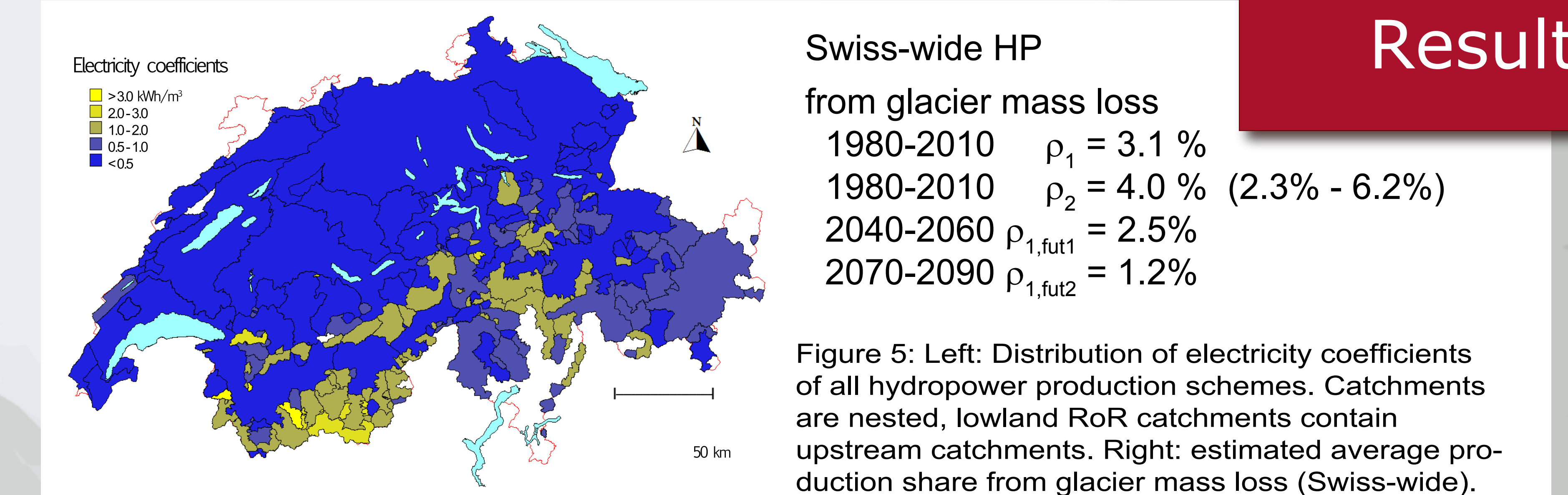


Figure 6 : Distribution of hydropower production from glacier mass loss; a) ratios  $p_1$  for the period 1981-2000, b) ratios for the period 2040-2060 based on GloGEM simulations; c) hydropower production from glacier mass loss in GWh yr<sup>-1</sup> for period 1981-2010, d) 2040-2060 based on GloGEM simulations.

## Conclusion

- ➔ Since 1980, 3.0% to 4.0% (1.0 to 1.4 TWh yr<sup>-1</sup>) of Swiss hydropower production directly provided by **glacier mass loss**
- ➔ For 2070-2090, a production reduction of 1.0 TWh yr<sup>-1</sup> is anticipated, with general production decline starting before 2040 - 2060
- ➔ Exception: **Rhone river** with today 6.4% to 8.6% of HP from glacier mass loss and reduction expected only by 2070-2090.